手続補正書

(法第１１条の規定による補正)

特許庁審査官　殿

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４．補正の対象　明細書及び請求の範囲

５．補正の内容　別紙のとおり

（１）「発明が解決しようとする課題」において、明細書第４頁第１８行目の「上記光路方向又は復路方向へ伝搬する各光の位相を」を「少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって」に補正する。

（２）「発明が解決しようとする課題」において、明細書第４頁第２０行目から同頁第２６行目の「入射すべき光を偏光方向に応じて分離する分離手段と、上記分離された各光の偏光方向を揃える偏光制御手段と、所定の周波数の変調信号を発振する発振手段と、互いに平行な反射鏡から構成され、上記偏光制御手段から互いにことなる角度で何れか一の反射鏡を介して入射された光を往路方向又は復路方向へ伝搬させることにより共振させる共振手段と、上記発振手段から供給された上記変調信号に応じて上記共振手段において共振させた光の位相を変調する光変調手段とを備える。」を「所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記端面間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する。さらに、本発明に係る光変調器は、上述した問題点を解決するために、所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記光伝搬手段を含む光路上にある少なくとも１つの反射

鏡をからなり、入射端側から光路方向へ伝搬する光を入射側に戻す光反射手段と、入射端と上記反射鏡との間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する。」に補正する。

（３）「発明が解決しようとする課題」において、明細書第５頁第８行目の「上記光路方向又は復路方向へ伝搬する各光を」を「少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって」に補正する。

（４）「発明が解決しようとする課題」において、明細書第５頁第１５行目の「変調手段を備える。」を「光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する。」に補正する。

（５）「発明が解決しようとする課題」において、明細書第５頁第１８行目から同頁第１９行目の「ことができる。これにより、」を「ことができる。しかも、導波路を往路方向へ伝搬する光のみならず、復路方向へ伝搬する光についても位相変調を施すことができるため変調効率を増加させることができる。これによ

り、」に補正する。

（6）請求の範囲第２８頁第１項の「上記光変調手段は、上記往路方向又は復路方向へ伝搬する各光の位相を変調し、上記光変調手段は、光を伝搬させる導波路である」を「上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する」に補正する。

（7）請求の範囲第２８頁第３項を削除する。

（8）請求の範囲第２９頁第８項の「上記光変調手段は、上記往路方向又は復路方向へ伝搬する各光を変調する」を「上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する」に補正する。

（9）請求の範囲第２９頁第９項「上記光変調手段は、上記往路方向又は復路方向へ伝搬する各光を変調する」を「上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する」に補正する。

（１０）請求の範囲第２９頁第１１項「光変調手段を備える」を「光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された

光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する」に補正する。

（１１）請求の範囲第２９頁第１２項の後に「１３．所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記光伝搬手段を含む光路上にある少なくとも１つの反射鏡をからなり、入射端側から光路方向へ伝搬する光を入射側に戻す光反射手段と、入射端と上記反射鏡との間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調することを特徴とする光変調器。」を追加する。

６．添付書類の目録

明細書第４頁、第４／１頁、第５頁及び第５／１頁

請求の範囲第２８頁、第２８／１頁、第２９頁及び第２９／１頁

を伝搬する光の偏光方向に強く依存する。このため、特定の偏光方向の光のみしか変調することができないという問題点があった。

さらに、導波路202内を伝搬させる光の偏光方向を調整するために偏光保存ファイバを配設する必要があるが、労力やコストの負担が過大となるという問題点もあった。

そこで、本発明は、上述した問題点に鑑みて案出されたものであり、その目的とするところは、光共振器内を共振する光に簡単な構成で往復変調を施すことにより、位相変調に必要な電力を増加させることなく、変調効率を改善させることができる光周波数コム発生器並びに光変調器を提供することにある。

また、本発明の他の目的は、入射される光の偏光方向に支配されることなく、変調効率を改善することができる光変調器を提供することにある。

本発明に係る光周波数コム発生器は、上述した問題点を解決するために、所定の周波数の変調信号を発振する発振手段と、互いに平行な入射側反射鏡及び出射側反射鏡から構成され、入射側反射鏡を介して入射された光を往路方向又は復路方向へ伝搬させることにより共振させる共振手段と、上記入射側反射鏡と上記出射側反射鏡との間に配され、上記発振手段から供給された上記変調信号に応じて上記共振手段において共振された光の位相を変調し、上記入射された光の周波数を中心としたサイドバンドを上記変調信号の周波数の間隔で生成する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する。

また、本発明に係る光変調器は、上述した問題点を解決するために、所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記端面間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調

信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する。

さらに、本発明に係る光変調器は、上述した問題点を解決するために、所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記光伝搬手段を含む光路上にある少なくとも1つの反射鏡をからなり、入射端側から光路方向へ伝搬する光を入射側に戻す光反射手段と、入射端と上記反射鏡との間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する。

このような構成の光周波数コム発生器並びに光変調器では、導波路を往路方向へ伝搬する光のみならず、復路方向へ伝搬する光についても位相変調を施すことがで

きるため変調効率を増加させることができる。

また、本発明に係る光変調器は、上述した問題点を解決するために、入射すべき光を偏光方向に応じて分離する分離手段と、上記分離された各光の偏光方向を同一方向へ制御する偏光制御手段と、所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記端面間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する。

さらに、本発明に係る光変調器は、上述した問題点を解決するために、入射すべき光を偏光方向に応じて分離する分離手段と、上記分離された各光の偏光方向を同一方向へ制御する偏光制御手段と、所定の周波数の変調信号を発振する発振手段と、互いに平行な反射鏡から構成され、上記偏光制御手段から互いに異なる角度で何れか一の反射鏡を介して入射された光を往路方向又は復路方向へ伝搬させることにより共振させる共振手段と、上記発振手段から供給された上記変調信号に応じて上記共振手段において共振された光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調する。

このような構成の光変調器では、仮に光伝搬手段を構成する材料の屈折率や変調効率がある特定の偏光方向に強く依存する場合に、当該偏光方向に応じて光分離手段において分離された各光の偏光方向を同一方向に制御することができる。しかも、導波路を往路方向へ伝搬する光のみならず、復路方向へ伝搬する光についても位

相変調を施すことができるため変調効率を増加させることができる。これにより、供給される光がいかなる偏光成分を有する場合であっても、これに依存することなく高効率な位相変調を実現させることができる。

本発明の更に他の目的、本発明によって得られる具体的な利点は、以下に説明される実施の形態の説明から一層明らかにされる。

図面の簡単な説明

[図１]図１は、従来における光周波数コム発生器の原理的な構成を示す図である。

[図２]図２は、従来における導波路型光周波数コム発生器の原理的な構成を示す図である。

[図３]図３は、本発明を適用した光周波数コム発生器の構成を示す図である。

[図４]図４は、本発明を適用した光周波数コム発生器における電極の構成について

請求の範囲

[1] 1.(補正後)所定の周波数の変調信号を発振する発振手段と、互いに平行な入射側反射鏡及び出射側反射鏡から構成され、入射側反射鏡を介して入射された光を往路方向又は復路方向へ伝搬させることにより共振させる共振手段と、上記入射側反射鏡と上記出射側反射鏡との間に配され、上記発振手段から供給された上記変調信号に応じて上記共振手段において共振された光の位相を変調し、上記入射された光の周波数を中心としたサイドバンドを上記変調信号の周波数の間隔で生成する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調することを特徴とする光周波数コム発生器。

[2] 2.上記入射側反射鏡及び/又は上記出射側反射鏡は、上記光変調手段の入射側端面及び/又は出射側端面に形成された反射膜であることを特徴とする請求項1記載の光周波数コム発生器。

[3] 3.(削除)

[4] 4.上記電極の一端には、他端から供給された変調信号を反射させるための反射器、並びに当該反射された変調信号の位相を調整するための移相器が配設されてなることを特徴とする請求項1記載の光周波数コム発生器。

[5] 5.上記移相器は、上記反射された変調信号の位相を上記電極の形状、上記変調信号の周波数、並びに上記導波路の群屈折率に応じて調整することを特徴とする請求項4記載の光周波数コム発生器。

[6] 6.上記電極の一端は、他端から供給された変調信号を反射させるための切断点又は短絡点が設けられてなることを特徴とする請求項3記載の光周波数コム発生器。

[7] 7.上記電極における切断点又は短絡点は、上記変調信号の周波数、反射時

の位

相シフト並びに上記導波路の群屈折率に応じて調整されていることを特徴とする請求項6記載の光周波数コム発生器。

[8] 8.(補正後)所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記端面間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調することを特徴とする光変調器。

[9] 9.(補正後)入射すべき光を偏光方向に応じて分離する分離手段と、上記分離された各光の偏光方向を同一方向へ制御する偏光制御手段と、所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記端面間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調することを特徴とする光変調器。

[10] 10.上記光伝搬手段は、上記入射された光を、結晶内部を全反射させつつ伝搬させることを特徴とする請求項9記載の光変調器。

[11] 11.(補正後)入射すべき光を偏光方向に応じて分離する分離手段と、上記分離された各光の偏光方向を同一方向へ制御する偏光制御手段と、所定の

周波数の変調信号を発振する発振手段と、互いに平行な反射鏡から構成され、上記偏光制御手段から互いに異なる角度で何れか一の反射鏡を介して入射された光を往路方向又は復路方向へ伝搬させることにより共振させる共振手段と、上記発振手段から供給された上記変調信号に応じて上記共振手段において共振された光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調することを特徴とする光変調器。

[12] 12. 上記光変調器における上記分離手段は、複屈折材料により構成されることを特徴とする請求項11記載の光変調器。

[13] 13. (追加)所定の周波数の変調信号を発振する発振手段と、何れか一の端面を介して入射された光を往路方向又は復路方向へ伝搬させる光伝搬手段と、上記光伝搬手段を含む光路上にある少なくとも1つの反射鏡をからなり、入射端側から光路方向へ伝搬する光を入射側に戻す光反射手段と、入射端と上記反射鏡との間に配され、上記発振手段から供給された上記変調信号に応じて上記伝搬する光の位相を変調する光変調手段とを備え、上記光変調手段は、少なくとも電気光学効果を有する基板に形成された光導波路と、上記光導波路上に形成され上記発振手段から発振された変調信号を往路方向又は復路方向へ伝搬させるための電極からなり、上記往路方向へ伝搬する光の位相を上記往路方向へ伝搬する変調信号によって変調し、また、上記復路方向へ伝搬する光の位相を上記復路方向へ伝搬する変調信号によって変調することを特徴とする光変調器。

AMENDMENT

(AMENDMENT under Article 11)

To: Hon. Commissioner, Patent Office

1. Indication of the International Application

PCT/JP2004/016325

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4. Item to be Amended DESCRIPTION and CLAIMS

5. Contents of Amendment As per attached sheet

(1) In the 'Problem to be solved by the Invention', the passage on page 8 lines 5 to 7 of the specification running: 'The optical modulating means phase-modulates the light propagated in the outward path direction or the light propagated in the

backward path direction.' is corrected to read: 'The optical modulating means includes at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.'

(2) In the 'Problem to be solved by the Invention', the passage on page 8 lines 8 to 19 of the specification running: 'For accomplishing the above objects, an optical modulator according to the present invention comprises separating means for separating the incident light depending on the directions of polarization, polarized light control means for matching the directions of polarization of light components, obtained on separation, and oscillation means for oscillating a modulating signal of a preset frequency. The optical modulator also comprises resonator means formed by a pair of reflective mirrors, arranged parallel to each other, for propagating light incident from the polarized light control means via one of the reflective mirrors at respective different angles in the outward path direction or in the backward path direction for causing the state of resonance. The optical modulator further comprises light modulation means for modulating the phase of light, set in the

resonant state by the resonator means, depending on the modulating signal supplied from the modulating means.' is corrected to read: 'For accomplishing the above objects, an optical modulator according to the present invention comprises oscillation means for oscillating a modulating signal of a preset frequency, light propagating means for propagating the light incident on one end face thereof in the outward path direction or in the backward path direction, and optical modulating means arranged between the end faces for modulating the phase of the propagated light in dependence upon the modulating signal supplied from the oscillation means. The optical modulating means includes at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.

For accomplishing the above objects, an optical resonator according to the present invention comprises oscillation means for oscillating a modulating signal of a preset frequency, light propagating means for propagating the light incident on one end face thereof in the outward path direction or in the backward path direction, and light reflecting means including at least one reflecting mirror provided on a

light path inclusive of the light propagating means. The light reflecting means returns the light propagated from the light incident side in the light path direction to the light incident side. The optical resonator also includes optical modulating means arranged between the light incident side and the reflecting mirror and adapted for phase-modulating the propagated light depending on the modulating signal supplied from the oscillation means. The optical modulating means includes at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.'

(3) In the 'Problem to be solved by the Invention', the passage on page 9 lines 12 to 14 of the specification running: 'The optical modulating means modulates the light propagated in the outward direction or in the backward direction' is corrected to read: 'The optical modulating means includes at least a light waveguide path, formed on a substrate exhibiting electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction.

The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.'

(4) In the 'Problem to be solved by the Invention', the passage on page 10 lines 3 to 6 of the specification running: 'and light modulation means for phase-modulating the light, which is set in resonant state by the resonator means, in dependence upon the modulating signal supplied from the oscillation means' is corrected to read: 'and light modulation means including at least a light waveguide path, formed on a substrate exhibiting electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.'

(5) In the 'Problem to be solved by the Invention', the passage on page 10 lines 7 to 12 of the specification running: 'With the optical modulator, in case the refractive index or the modulation efficiency of a material of light propagating means is strongly dependent on a particular direction of light polarization, the directions of light polarization of respective light components, separated by the light separating

means depending on the directions of light polarization, may be controlled to the same direction of polarization. Thus,' is corrected to read: 'With the optical modulator, in case the refractive index or the modulation efficiency of a material of light propagating means is strongly dependent on a particular direction of light polarization, the directions of light polarization of respective light components, separated by the light separating means depending on the directions of light polarization, may be controlled to the same direction of polarization. Moreover, since the phase modulation may be applied not only to light propagated on the waveguide path in the outward direction but also to light propagated on the waveguide path in the backward direction, the modulation efficiency may be improved. Thus,'.

(6) In claim 1 on page 51, the passage running: 'said optical modulating means phase-modulating the light propagated in said outward path direction or in said backward path direction; said optical modulating means being a waveguide path for propagating the light thereon.' is corrected to read: 'said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while

phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction.'

(7) The claim 3 on page 52 of the specification is deleted.

(8) In claim 8 on page 53 of the specification running: 'said optical modulating means modulating the light propagated in said outward path direction or in the backward path direction.' is corrected to read: 'said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction.'

(9) In claim 9 on page 53 of the specification running: 'said optical modulating means modulating the light propagated in said outward path direction or the light propagated in said backward direction' is corrected to read: 'said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical

modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction'

(10) In claim 11 on page 54 of the specification running: 'and optical modulating means for phase-modulating the light caused to be resonant in said resonance means, responsive to said modulating signal supplied for said oscillation means.' is corrected to read: 'and optical modulating means for phase-modulating the light caused to be resonant in said resonance means, responsive to said modulating signal supplied for said oscillation means, said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction.'

(11) After claim 12 on page 54 of the specification, add: '13. An optical resonator comprising oscillation means for oscillating a modulating signal of a preset frequency, light propagating means for propagating the light incident on one end

face thereof in the outward path direction or in the backward path direction, light reflecting means including at least one reflecting mirror provided on a light path inclusive of said light propagating means, said light reflecting means returning the light propagated from the light incident side in the light path direction to the light incident side, and optical modulating means arranged between the light incident side and said reflecting mirror and adapted for phase-modulating the propagated light depending on said modulating signal supplied from said oscillation means; said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction.'

6. List of Attached Papers

Pages 8, 8/1, 8/2, 9, 10 and 10/1

Claims, pages 51, 51/1, 52, 53, 53/1, 54 and 54/1

reflecting mirror, for phase-modulating the light, resonant in the resonator means, responsive to the modulating signal supplied from the oscillation means, for generating a plurality of sidebands spaced apart from one another by an interval corresponding to the frequency of the modulating signal, with the frequency of the incident light as center. The optical modulating means includes at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.

For accomplishing the above objects, an optical modulator according to the present invention comprises oscillation means for oscillating a modulating signal of a preset frequency, light propagating means for propagating the light incident on one end face thereof in the outward path direction or in the backward path direction, and optical modulating means arranged between the end faces for modulating the phase of the propagated light in dependence upon the modulating signal supplied from the oscillation means. The optical modulating means includes at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal,

oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.

For accomplishing the above objects, an optical resonator according to the present invention comprises oscillation means for oscillating a modulating signal of a preset frequency, light propagating means for propagating the light incident on one end face thereof in the outward path direction or in the backward path direction, and light reflecting means including at least one reflecting mirror provided on a light path inclusive of the light propagating means. The light reflecting means returns the light propagated from the light incident side in the light path direction to the light incident side. The optical resonator also includes optical modulating means arranged between the light incident side and the reflecting mirror and adapted for phase-modulating the propagated light depending on the modulating signal supplied from the oscillation means. The optical modulating means includes at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal

propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.

With the optical frequency comb generator and the optical modulator, described above, phase modulation may be applied to both the light propagated in

the outward path direction and that propagated in the backward path direction, on the waveguide path, thereby increasing the modulation efficiency.

For accomplishing the above objects, an optical modulator according to the present invention comprises separating means for separating the incident light depending on the directions of polarization, polarized light control means for controlling the directions of polarization of light components, obtained on separation, to the same direction, and oscillation means for oscillating a modulating signal of a preset frequency. The optical modulator also comprises light propagating means for propagating the light incident on one end face thereof in the outward path direction or in the backward path direction, and optical modulating means arranged between the end faces for phase-modulating the propagated light in dependence upon the modulating signal supplied from the oscillating means. The optical modulating means includes at least a light waveguide path, formed on a substrate exhibiting electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.

For accomplishing the above objects, an optical modulator according to the

present invention comprises separating means for separating the incident light depending on the directions of polarization, polarized light control means for controlling the direction of polarization of light components obtained on separation, to the same direction of polarization, and oscillation means for oscillating a modulating signal of a preset frequency. The optical modulator also includes resonator means made up of reflecting mirrors placed parallel to each other, and configured for propagating light incident at respective different angles from the polarization control means via one of the reflecting mirrors in the outward path direction or in the backward path direction for causing the resonant state, and light modulation means including at least a light waveguide path, formed on a substrate exhibiting electro-optical effect, and an electrode formed on the light waveguide path for propagating the modulating signal, oscillated by the oscillation means, in the outward path direction or in the backward path direction. The optical modulating means phase-modulates the light propagated in the outward path direction by the modulating signal propagated in the outward path direction, while phase-modulating the light propagated in the backward path direction by the modulating signal propagated in the backward path direction.

With the optical modulator, in case the refractive index or the modulation efficiency of a material of light propagating means is strongly dependent on a particular direction of light polarization, the directions of light polarization of respective light components, separated by the light separating means depending on

the directions of light polarization, may be controlled to the same direction of polarization. Moreover, since the phase modulation may be applied not only to light propagated on the waveguide path in the outward direction but also to light propagated on the waveguide path in the backward direction, the modulation efficiency may be improved. Thus, even if the light supplied contains one or more optional components of polarized light, the optical phase modulation may be applied to the supplied light to high efficiency without dependency upon these polarized light components.

Other objects and specified advantages of the present invention will become more apparent on reading the following explanation of preferred embodiments thereof in conjunction with the drawings.

Fig.1 is a schematic view of a structure illustrating the operating principle of a conventional optical frequency comb generator.

CLAIMS

1. (Amended) An optical frequency comb generator comprising:

oscillation means for oscillating a modulating signal of a preset frequency;

resonator means composed of a light incident side reflecting mirror and a light exiting side reflecting mirror, parallel to said light incident side reflecting mirror, and configured for propagating light incident via said light incident side reflecting mirror in the outward path direction or in the backward path direction for causing the resonant state of the incident light; and

optical modulating means arranged between said light incident side reflecting mirror and the light exiting side reflecting mirror, for phase-modulating the light resonant in said resonator means, responsive to said modulating signal supplied from said oscillation means, for generating a plurality of sidebands spaced apart from one another by an interval corresponding to the frequency of said modulating signals, with the frequency of the incident light as center;

said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path

direction by said modulating signal propagated in said backward path direction.

2. The optical frequency comb generator according to claim 1 wherein said light incident side reflecting mirror and/or the light exiting side reflecting mirror is a reflecting film formed on a light incident side end face and/or a light exiting side end face of said optical modulating means.

3. (Deleted)

4. The optical frequency comb generator according to claim 3 further comprising:

a reflector and a phase shifter, provided on one end of said electrode; said reflector reflecting the modulating signal supplied from the opposite end of said electrode; said phase shifter adjusting the phase of the reflected modulating signal.

5. The optical frequency comb generator according to claim 4 wherein said phase shifter adjusts the phase of said reflected modulating signal in dependence upon the shape of said electrode, frequency of said modulating signal and the group refractive index of said waveguide path.

6. The optical frequency comb generator according to claim 3 wherein one end of said electrode is provided with a cut point or a shorting point for reflecting the modulating signal supplied from the opposite end thereof.

7. The optical frequency comb generator according to claim 5 wherein said cut point or the shorting point in said electrode is adjusted in dependence upon the frequency of said modulating signal, phase shift at the time of reflection or the group refractive index of said waveguide path.

8. (Amended) An optical resonator comprising oscillation means for oscillating a modulating signal of a preset frequency, light propagating means for propagating the light incident on one end face thereof in the outward path direction or in the backward path direction, and optical modulating means arranged between said end faces for modulating the phase of the propagated light in dependence upon said modulating signal supplied from said oscillation means; said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction.

9. (Amended) An optical modulator comprising:

separating means for separating the incident light depending on the directions of polarization, polarized light control means for controlling the direction of polarization of light components obtained on separation to the same direction, oscillation means for oscillating a modulating signal of a preset frequency, light propagating means for propagating the light incident on one end face thereof in the outward path direction or in the backward path direction, and optical modulating

means arranged between said end faces for phase-modulating the propagated light in dependence upon said modulating signal supplied from said oscillating means; said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction.

10. The optical modulator according to claim 9 wherein said light propagating means is a crystal device within which light is propagated as said light undergoes total reflection therein.

11. (Amended) An optical modulator comprising:

separating means for separating the incident light depending on the directions of polarization, polarized light control means for controlling the direction of polarization of light components obtained on separation, to the same direction of polarization, oscillation means for oscillating a modulating signal of a preset frequency, resonator means made up of reflecting mirrors placed parallel to each other, and configured for propagating light incident at respective different angles from said polarization control means via one of said reflecting mirrors in the outward path direction or in the backward path direction for causing the resonant state, and optical modulating means for phase-modulating the light caused to be resonant in said resonance means, responsive to said modulating signal supplied for said oscillation means; said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction.

12. The optical modulator according to claim 11 wherein said separating means in

the optical modulator is formed of a birefringent material.

13 (Added) An optical resonator comprising oscillation means for oscillating a modulating signal of a preset frequency, light propagating means for propagating the light incident on one end face thereof in the outward path direction or in the backward path direction, light reflecting means including at least one reflecting mirror provided on a light path inclusive of said light propagating means, said light reflecting means returning the light propagated from the light incident side in the light path direction to the light incident side, and optical modulating means arranged between the light incident side and said reflecting mirror and adapted for phase-modulating the propagated light depending on said modulating signal supplied from said oscillation means; said optical modulating means including at least a light waveguide path, formed on a substrate exhibiting an electro-optical effect, and an electrode formed on said light waveguide path for propagating said modulating signal, oscillated by said oscillation means, in the outward path direction or in the backward path direction, said optical modulating means phase-modulates the light propagated in said outward path direction by said modulating signal propagated in said outward path direction, while phase-modulating the light propagated in said backward path direction by said modulating signal propagated in said backward path direction.